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GIS based study of burglary crime incidences in Ahmednagar City, Maharashtra, India

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Abstract

The present research seeks to identify burglary crime incidences in Ahmednagar city of Maharashtra in relation to the socio-economic and environmental contexts of the location of such crimes. The study relies on hotspot mapping with the help of the Kernel Density Estimation (KDE) technique. The spatial pattern in the distribution of burglary incidences in the city reveals that such incidences of crimes tend to localise around areas of high socioeconomic status such as the city centre, commercial and recreational centres which are generally located near major transportation routes and nodes. The spatial proximity of offenders around high socio-economic areas is found to be the most significant correlate for burglary crime in the current study. The age of offenders and their pattern of co- or solo offending in burglary contribute to the spatial concentration of crimes. The causes of burglary in the city are compared with the experiences of the Western countries and the findings of the research are expected to help develop policies and strategies to bring down crime rates in the South Asian context.

Keywords: *Spatial analysis; crime analysis; hotspot analysis; burglary; GIS; crime geography; India*

Introduction

Geography of crime is a branch of geography that is related to social ecology as the former studies spatial aspects of crime whereas the latter is concerned with the areal characteristics of the offenders. In this paper, different theories of crime-geography have been put to the test. Received theories on the geography of crime however draw their strength from experiences of crimes committed in the western countries. For example, *relative activity theory* (Cohen and Felson, 1979) speaks about the opportunity that offenders get when there is a combination of a motivated offender, a suitable target, and the absence of capable guardians. *Geometric theory of crime* (Brantingham & Brantingham, 1981) on the other hand focuses on the relationship between the distribution of targets and offenders, their mobility, and criminal social network.

Spatial aspects of crime-geography including the occurrence of different types of crimes mostly follow these two dominant theories. Studies like that of Townsley *et al.* (2000) have found that repeated victimization in unstable hotspots i.e. areas characterised by significant change in spatial and/or temporal hotspots, have brought down the rate of

crimes by 25 percent in Australia. Another study from Madison City showed that aspects such as ownership of the house, public assistance, poverty, unemployment, low literacy, and low income influence the growth in the number of offenders (Hughes 2008). It has also been observed that criminal activities in general and burglaries, in particular, are influenced more by the location of rich neighbourhoods, socio-economic and ethnic differences, and lack of guardians (Kumar and Chandrasekar 2011). Crimes are also found to be predominant in areas of high population density such as rich neighbourhoods in close spatial proximity to the slums (Thangavelu, Sathyaraj, and Balasubramanian, 2013).

In recent years, India has been vulnerable to a number of crimes such as burglary, theft, fraud, assault, and cybercrime, making it one of the most affected countries in the world (Chauhan and Kumar 2016). The northern state of India, Uttar Pradesh alone accounts for 9.5 percent of the total criminal incidents in the country followed by Madhya Pradesh (8.9%), Maharashtra (8.8%), and Kerala (8.7%) (Kumar *et al.*, 2012). Among the union territories, the national capital region of Delhi is susceptible to higher crime rates of 974.9 per 1,00,000 population compared to the national average of 233.6 per 1,00,000 population. The reason for this abnormally high crime rate in India is because of the large and ever-growing population characterised by extreme inequalities. An estimated 230 million people in India are poor in 2020 (Basole *et al.*, 2021) and the ever-widening gap between the rich and the poor just makes the situation worse. Only a few people have access to resources, good education, sanitation facilities, jobs, and so on. Nevertheless, reduction in crime is one of the most important imperatives for a better quality of life. Since spatial factors are important determinants of crime occurrences in cities elsewhere, crime management and policies need to take this dimension seriously. Identification of hotspots of different types of crimes is one such aspect which is increasingly being viewed as a significant spatial manifestation of crimes. Identification of these hotspots and their spatial connection and characteristics can be an important step in crime management. Though limited in number, there are some important studies undertaken in the Indian context with clear spatial perspectives, particularly for the national capital region (Gupta, 2020; Singh and Gupta, 2023). Gupta (2020) for example identified crime hotspots in Delhi while Singh and Gupta (2023) studied kidnappers' spatial mobility patterns in Delhi's urban system.

Ahmednagar is the largest district of Maharashtra and is one of the most crime-affected (NCRB, 2021) districts. The greater crime rate of the district is attributed to the large geographical spread of the district. It has been found that most of the settlements or localities in the district are scattered, making them vulnerable to robberies and burglaries. The presence of de-notified 'criminal tribes' in some regions of the country is considered as a factor for heightened crime rates though often due to the stigma associated with these unfortunate communities who are always viewed with suspicion due to the colonial categorisation of these communities as 'criminal tribes' (Sardar and Nayak, 2019, 2020, 2023). Kadam (2022) in his study of the Pardhi community of Maharashtra found that this de-notified tribal group largely concentrated in the Ahmednagar district

has been stigmatised and often perceived to be engaged in criminal activities such as burglary in the district.

The present study identifies major hotspots of burglary crimes in Ahmednagar city. Though burglars belong to a wide range of age cohorts, burglaries committed by underage children are excluded from the analysis as their number is negligible. Only the adult offenders living in the study area and the hotspots are included in the study.

The analysis of the hotspots of burglary as a crime in Ahmednagar city has been undertaken to unravel the socio-spatial attributes responsible for such activities by assessing the proximity of the burglars from the crime hotspots of the city; studying the role of the offenders' age and the types of offences in different crime hotspots as identified in the city and finding out the role of the density of population and population type in the hotspots.

Data

The statistics of burglaries as reported in Ahmednagar City police jurisdiction (ACPJ) during 2011 and 2018 constitute the basis of the current analysis. In these seven years, as many as 979 burglaries were reported across the three ACPJ police sub-jurisdictions. According to the 2011 Indian census, ACPJ is home to 435,811 inhabitants in an area spread over 186 km^2. The Ahmednagar Municipal Corporation (urban area), which is home to more than 80 percent of the population of the study area, includes the police sub-jurisdictions of Kotwali and Topkhana (Fig. 1). Rural areas are confined to the Camp Police Sub-jurisdiction, with the exception of Ahmednagar Cantonment Board, which houses the remaining population. During 2011 and 2018, the Topkhana police station experienced the highest incidences (54.8%) of burglary cases followed by Kotwali (27%) and Camp police sub-jurisdiction (18.2%).

Unfortunately, 160 out of a total of 979 reported cases of burglaries that were officially reported lacked or had inaccurate addresses included in the police files. The study therefore took into account the remaining 819 cases for further analysis. As many as 221 burglaries out of all the reported cases were solved by the arrest of at least one suspect in each instance totaling 272 suspects in all 221 cases. Therefore, 221 cases of burglary and 272 apprehended offenders finally constituted the numerical basis for the present investigation for analysing the spatial correlates of burglary incidences. The study used data from 81 cases of burglaries committed by 82 solo mature (adult) offenders and 131 burglaries cases committed by 192 offenders who committed the crime with the help of co-offenders.

Methods

The geographical analysis of burglary for the present study is based on visualization methods, specifically GIS-based crime maps prepared for the purpose of displaying the spatial distribution of burglaries, the proximity of offenders to burglary hotspots, characteristics of offenders, and the spatial distribution of burglary incidences. Kernel density estimation (KDE) in the ArcGIS has been profitably used to create hotspot maps of burglary cases. Instead of using manual classification, the density of burglary hotspots was categorized using the natural break method. Class breaks maximize the

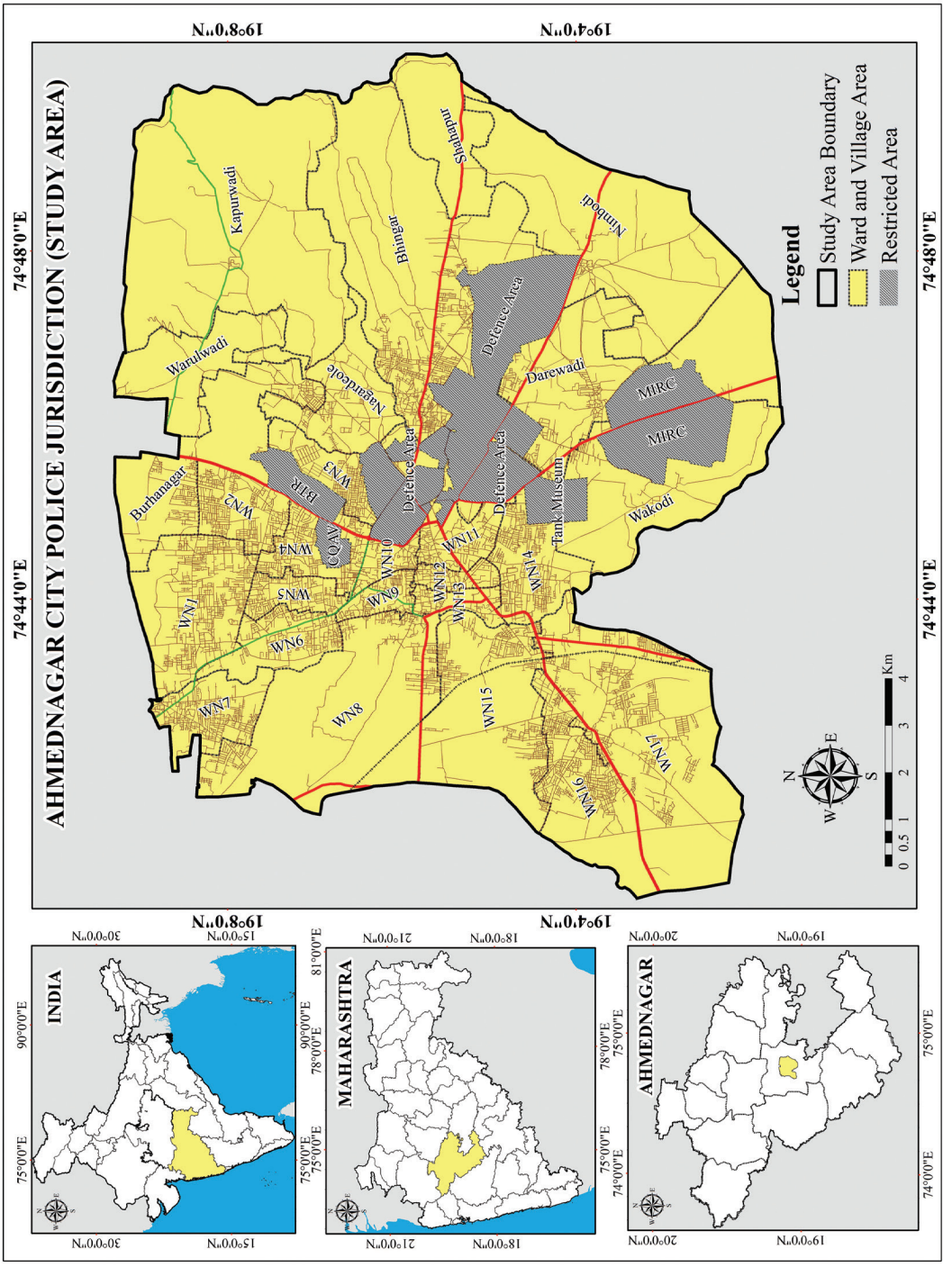

Fig. 1: The study area

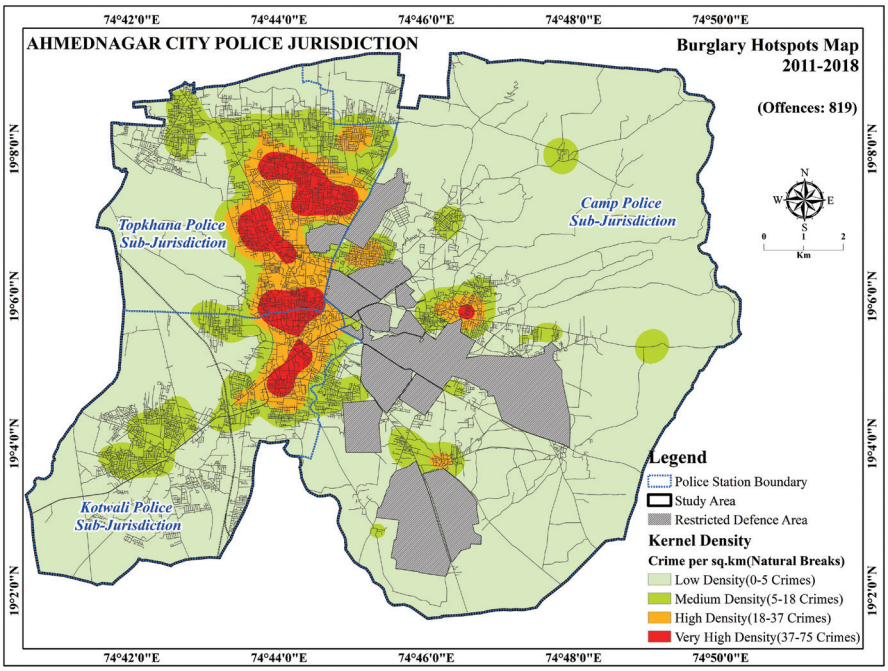

Fig. 2: Burglary hotspots of Ahmednagar city, 2011-2018

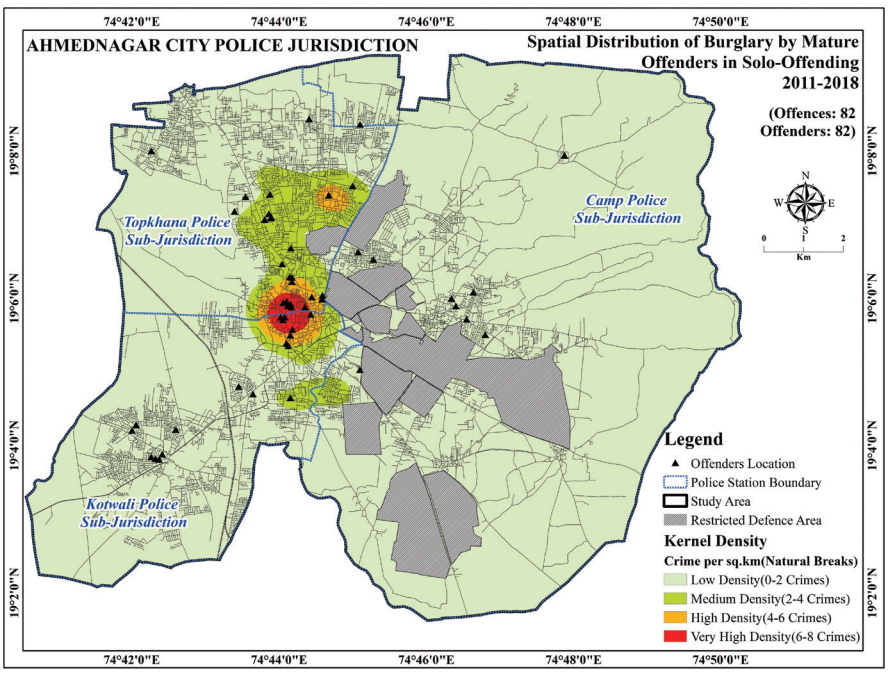

Fig. 3: Ahmednagar: Burglary distribution by adult offenders in solo-offending cases, 2011-2018

differences between classes and decrease the differences within classes in the natural break approach which eliminates potential classification errors. An interactive map displaying the spatial proximity of offenders with burglary hotspots was created using the raster-vector overlay technique. With this technique, the hotspots for burglary cases were overlaid with the GPS coordinates of the homes where the arrested crime perpetrators were found. Additionally, using this technique, maps were created that illustrate how the age of offenders and the type of offense (solo or co-offending) they committed affected the geographic distribution of burglary hotspots.

Results and discussion

The analysis relies solely on the visualization method which is crucial in understanding actual spatial spread and concentration of crime not limited to only the number of crime or crime rates within the given unit of area. Spatio-temporal hotspot maps prepared using visualization methods are tools for researchers to understand the space-time aspect of crime and to operationalize strategies for police to curb crime rates. Hotspot maps were prepared using Kernel Density Estimation (KDE) of GIS based tools and methods, and the findings are discussed in relation to diverse approaches to crime geography.

Hotspot analysis

Figure 2 shows the location of burglary hotspots in the police jurisdiction of Ahmednagar city. As can be seen, very high-density burglary hotspots were restricted to comparatively very tiny areas of ACPJ consisting of four major and one minor burglary hotspot (37-75 burglaries per Km^2). These show a longitudinal distribution of the hotspots extending northward from the city centre towards the suburbs. These four burglary hotspots are denoted as V, W, X, Y, and Z for the purpose of interpretation only (Fig. 2).

The Central Business District (CBD) and surrounding residential areas are closely spaced and surrounding the Y hotspots. This is the most congested area, where a daily influx of transitory residents congregates at numerous commercial, recreational, and shopping nodes via roads and some significant adjacent transportation hubs. This area is inhabited by residents who belong to the low and medium socio-economic status of the old city. According to Park and Burgess (1925) and Shaw and McKay (1969), the pattern of land use in this area is almost identical to the concentric zones in the older cities. According to the geometric theory of crime such transient crowded nodes and pathways offer favourable spaces for frequent criminal activities (Brantingham & Brantingham, 1981). These places constitute a major part of offenders' activity spaces through their criminal social network as many criminals actually live in low-class neighbourhoods in this area. Additionally, there are quite a few 'good' targets in the crowded nodes and paths. According to the geometric theory, crime rates are high in areas where suitable targets and offenders' awareness spaces intersect. This could be the reason for the high burglary rates in the Y hotspot. Burglars look for individual victims or their properties (houses or shops) to break into whenever they find an opportunity to commit the crime in such times and locations marked by the absence of

property owners or capable guardians (Cohen & Felson, 1979). This happens both during the day and at night.

North of the Y hotspot, there are two other hotspots identified namely W and X. The middle-class and upper-class residential areas along the primary and internal road transportation routes connecting the city's CBD to periphery expenses make up most of the population in the hotspot expanse situated halfway between the Y and the northernmost hotspot i.e. W and the northernmost hotspot. Close to X burglary hotspot and south of the CBD are the slums. According to the geometric theory, crime rates are higher in residential areas near public transportation arteries and low-income housing. Criminals who use transit routes to get from one place to another are well aware of the suitable targets living in nearby residential areas. Additionally, neighbourhoods near transportation hubs help offenders to remain unidentified or unnoticed which is convenient for them to flee after harming their victims. Therefore, residential areas in close proximity to transit hubs bear the brunt of a higher level of crime, which explains the reason for the high-frequency burglary in this hotspot. Furthermore, it has been noted that many criminals stay in slums since these locations are the most economical for them, and because of the heterogeneous and anonymous character of the slums allowing the burglars to easily conceal their identities (Shaw and McKay 1969). According to the geometric theory of crime, the location of slums or low-class neighbourhoods in close spatial proximity always promotes a higher rate of crime than their counterparts farther away. This could be yet another reason for the emergence of X burglary hotspots.

The high-class dwellings and the main internal road transportation network in the Savedi suburban area constitute the northernmost hotspot. The proximity to transit routes, as was mentioned in the preceding hotspot, also contributes to this hotspot for break-ins. A second factor contributing to the large size of W burglary hotspots may be the attractiveness of the targets (houses/properties) in the Savedi suburban area. According to the rational choice theory, offenders target more lucrative locations for better earnings. Studies on the role of distance from residence to crime point out that criminals prefer to go farther away to commit burglary for more lucrative targets than the less lucrative ones available nearby (Ackerman and Rossmo, 2015; Vandeviver *et al*, 2015; Chen *et al*.,2013). Therefore, regardless of distance from slum or low-class homes, this suburban high-class residential stretch emerges as a hotspot for burglaries.

The V burglary hotspot for break-ins is in the Bhingar neighbourhood lying to the east, comparatively smaller as a hotspot for burglaries. The majority of the low-class homes in the area under this burglary hotspot are socially dysfunctional as per social disorganization theory (Shaw and McKay 1969), where houses have poor overall economic conditions due to the concentration of low-income earning tenants who generally lack informal social control among the residents. Therefore, from the perspective of criminals, there are not many profitable targets for committing burglaries in such neighbourhoods. This could be the reason for a local hotspot for petty burglaries.

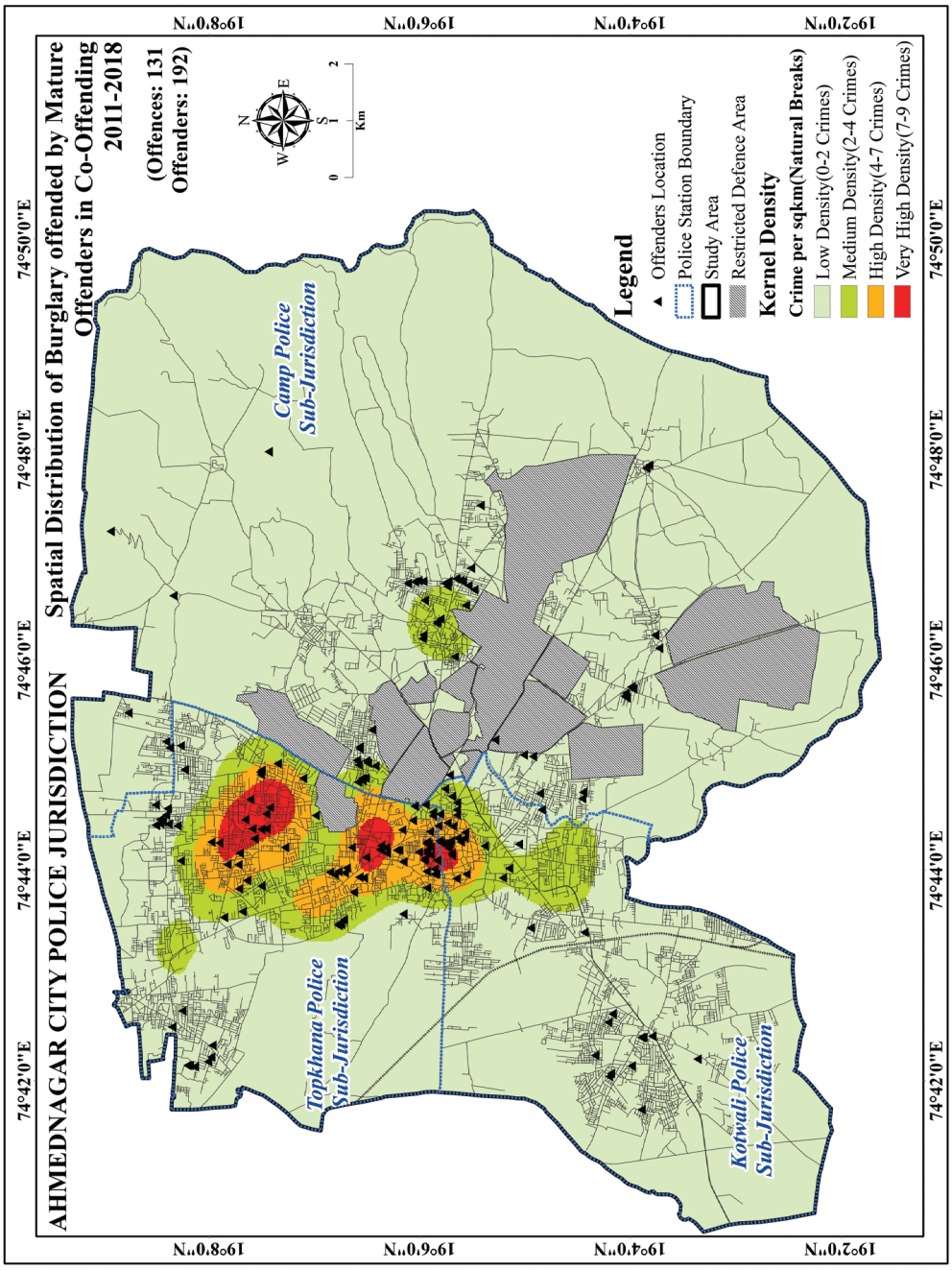

Fig. 4: Ahmednagar: Burglary distribution by mature offenders in co-offending cases, 2011-2018

Spatial correlates

The proximity of the offenders' home location to the crime scene, the age of the offenders, and the type of crime were all taken into account by the current study as spatial correlates of burglary based on the reviewed literature.

Age of offenders and type of offending

The analysis of the age and kind of offense characteristics display interesting intra-city spatial patterns of burglary cases. For the present analysis, juvenile offenders are classified as those under the age of 20, and adult offenders are over 20 years of age. Burglary Offenses are carried out either as solo- or as co-offending type when they occur in association with two or more offenders. Only 30 of the 500 perpetrators are juvenile offenders, while the remaining are adult or mature offenders, showing less involvement of young offenders in acts of burglary. There are two reasons why this is the case. First, the act of burglary requires certain expertise such as evaluating the danger and reward of the target, identifying appropriate targets, and professionalizing the offense (Cornish and Clarke, 1987). Offenders typically pick up these skills as they gain more experience in committing burglaries as they get older. Therefore, it is possible that just a small number of juvenile criminals participated in acts of burglary in this area elsewhere. Second, because of their age, juvenile offenders have smaller space awareness compared to their senior counterparts, severely restricting their large-scale involvement in burglary-linked crimes (Brantingham and Brantingham, 1981). Age therefore appeared as an important determinant in the composition of the criminals involved in burglary as a profession. As mentioned earlier, juvenile offenders have been excluded from the study due largely to their marginal role in this kind of crime.

The distribution of burglary offenses committed by adult offenders in solo-offending and co-offending cases in ACPJ from 2011 to 2018 reveals interesting patterns. It is clear from fig. 3 and 4 that burglaries committed by adult offenders in groups tend to be more widespread and violent than those committed by individual burglars. This is due to the need for establishing a network for committing burglary which is necessary to escape without severe consequences. Solo offenders lack the advantage of this network and are often caught red-handed. According to Brantingham and Brantingham (1981), inside their criminal social network, offenders frequently share information about appropriate targets and their surroundings. This helps the gang of offenders to be more aware of one another and permits them to extend their activity spread over a wider territory. This claim is supported by a number of journey-to-crime studies that found co-offending crimes have longer crime trips than solo-offending crimes (Bernasco, 2006; Sorensen, 2005; Van Koppen and Jansen, 1998; Xiao *et al.*, 2018), suggesting that offending type is a spatial correlate of burglary.

It is also seen that co-offending by adult offenders is localised in three separate pockets of high to the very high density of crime incidences. Despite the smaller spread of the high to very high density, this hotspot is surrounded by a significant concentration of offenders. This is perhaps due to the absence

of viable and profitable targets. The second pocket which was located to the north of the first, contains fewer criminals than the first. This region is bordered by middle-class to affluent residential communities and business districts along the main thoroughfares. The lower concentration of criminals involved in acts of burglary in this area is due to the higher cost of living; unaffordable by the burglars. The Savedi suburban region is one that has the third highest density of burglary cases. The larger spatial expansion of this region may be due to two factors. First, there is a greater concentration of offenders here who may have committed crimes close by. The second is that this location is seen as a profitable target area attracting offenders from farther away to commit crimes here. As a result, this place may have been the target of both nearby and distant offenders, resulting in increasing the density of burglary crimes here. All of these claims are in line with the rational choice theory (Clarke and Cornish, 1985) and the geometric theory of crime (Brantingham and Brantingham, 1981).

Conclusion

The use of KDE and the hybrid raster-vector overlay technique is beneficial in identifying burglary hotspots and determining the geographical correlates of burglary. Settlement distribution in the city has a strong relation with the burglary hotspots, which are conveniently situated around commercial, recreational, and residential locations close to transit hubs and pathways. Along with the overall economic health of the region, the spatial proximity of offenders is found to be the most significant spatial correlate in the city. The age of offenders and their pattern of co- or solo offending are also observed to vary over the city space. The results are largely consistent with many of the claims made by the geometric theory of crime, the social disorganization theory, and the routine activity hypothesis. These theories are grounded in empirical research in Western nations. Application of these theories to the spatial distribution of crime in Indian cities could be beneficial for crime control and reduction efforts.

Competing interest

The authors declare that they have no conflict of interest.

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